

WHAT IS CLAIMED IS:

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1. A method for locating a pattern, comprising:
- 5 providing a pattern image corresponding to the pattern to be located;
- extracting at least one pattern contour from the pattern image;
- generating vector information for each of said at least one pattern contours, relative to a reference point;
- creating at least one reference table for storing the vector information, each of said at least one reference tables corresponding to said at least one pattern contour;
- 10 providing a scene image, which will be searched for the pattern;
- extracting at least one scene contour from the scene image;
- generating vector information for each of said at least one scene contours; and
- determining whether the pattern has been located within the scene image using the at least one reference tables and the vector information for the at least one scene contours, and if so, identifying a location of the pattern within the scene image and an angle of rotation of the pattern within the scene image.
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2. The method of claim 1, wherein the step of extracting at least one pattern contour from the pattern image comprises:
- 20 locating at least one edge in the pattern image;
- recording a starting point for the at least one edge;
- crawling along the at least one edge of the pattern image;
- extracting a plurality of pixels from the at least one edge, beginning with the starting point and continuing with pixels identified while crawling along the at least one edge;
- 25 filtering the plurality of extracted pixels; and
- creating a pattern contour from the plurality of extracted pixels.
3. The method of claim 1, wherein the step of extracting at least one pattern contour from a pattern image comprises:
- 30 extracting at least one pattern contour from the pattern image;

identifying undetected edge points; and

modifying the at least one pattern contour to add any undetected edge points.

4. The method of claim 3, wherein the step of extracting at least one pattern contour from a pattern image further comprises:

removing aliased edge points from the at least one pattern contour;

spatially filtering the pattern contours; and

resampling the filtered pattern contours.

5. The method of claim 1, wherein the step of generating vector information for each of said at least one pattern contours comprises:

selecting a reference point for each of said at least one pattern contours; and

generating vector information for each of said at least one pattern contours, relative to the selected reference point.

6. The method of claim 1, wherein the step of generating vector information for each of said at least one pattern contours, relative to the selected reference point, comprises:

choosing an index point corresponding to a point along said at least one pattern contour;

establishing a front point and a back point for said index point, the front point and the back point defining a stick vector;

establishing a R vector from the index point to the selected reference point;

determining a contour curvature value for the index point, the contour curvature value being a shortest distance between the index point and the stick vector;

determining a stick angle, the stick angle being an angle between the stick and the horizontal axis; and

determining a SR angle for the index point, said SR angle being the angle between the stick vector and the R vector.

7. The method of claim 6, wherein a plurality of index points are chosen, and contour curvature values and SR angles are calculated, respectively, for each of said plurality of index

points

8. The method of claim 7, wherein the step of generating vector information for each of said at least one pattern contours, relative to the selected reference point, further comprises:

for each index point of said plurality of index points, determining a GR angle between a gradient of each of said index points and the respective R vectors for said index points.

9. The method of claim 6, wherein the step of creating at least one reference table containing said vector information comprises:

grouping the SR angles based on a contour curvature value;

grouping the stick angles based on the contour curvature value; and

grouping the R vector information based on the contour curvature value.

10. The method of claim 9, wherein the step of creating at least one reference table containing said vector information further comprises:

grouping the GR angles based on the contour curvature value at the index point.

11. The method of claim 6, wherein the SR angle is rotation invariant.

12. The method of claim 1, wherein the step of extracting at least one scene contour from a scene image comprises:

locating at least one edge in the scene image;

recording a starting point for the at least one edge of the scene image;

crawling along the at least one edge of the scene image;

extracting a plurality of pixels from the at least one edge, beginning with the starting point and continuing with pixels identified while crawling along the at least one edge of the scene image;

filtering the plurality of extracted pixels; and

creating a scene contour from the plurality of extracted pixels.

13. The method of claim 1, wherein the step of generating vector information for each of said at least one scene contours comprises:

choosing at least one scene index point corresponding a point along said at least one scene contour;

determining a scene stick angle, the scene stick angle being an angle between a scene stick and the horizontal axis; and

determining a scene contour curvature and a scene SR angle for each of said at least one scene index points.

14. The method of claim 13, wherein the step of generating vector information for each of said at least one scene contours further comprises:

determining a scene GR angle for each of said at least one scene index points.

15. The method of claim 1, wherein the step of determining whether the pattern has been located comprises:

calculating at least one potential reference point based on the extracted scene contour vector information and recording the instance of each of said at least one potential reference points;

calculating at least one potential angle of rotation based on the extracted scene contour vector information and recording the instance of each of said at least one potential angles of rotation;

identifying a location of the pattern within the scene image using the recorded potential reference points; and

determining an angle of rotation for the pattern within the scene image using the recorded potential angles of rotation.

16. The method of claim 15, wherein the step of calculating at least one potential reference point comprises:

calculating a potential reference point for each point in the reference table.

17. The method of claim 16, wherein the potential reference point is calculated from the SR angles and the vector information.

18. The method of claim 15, wherein the step of calculating at least one potential reference point based on the extracted scene contour vector information and recording the instance of each of said at least one potential reference points comprises:

adding the potential reference point to a reference point accumulator.

19. The method of claim 15, wherein the step of calculating at least one potential angle of rotation based on the extracted scene contour vector information and recording the instance of each potential angle of rotation comprises:

determining an angle difference between the scene stick angle and the stick angle in the reference table; and

adding the potential angle of rotation to an angle accumulator.

20. The method of claim 15, wherein the step of determining an angle of rotation for the pattern image comprises:

clustering the potential angles of rotation; and

identifying at least one potential angle of rotation where clustering has occurred beyond a predetermined threshold.

21. A method for pattern recognition, comprising:

extracting pattern vector information from at least one pattern image, each pattern image having a pattern reference point;

creating a reference table containing the pattern vector information for each of the at least one pattern image;

extracting scene contour information from a scene image;

calculating a potential reference point based on the scene contour information and the reference table;

matching the potential reference point with one of the at least one pattern reference

points; and

identifying a pattern image corresponding to the matching pattern reference point.

22. The method of claim 21, further comprising:

identifying an angle of rotation for the scene image.

23. The method of claim 21, wherein the pattern vector information includes a rotation invariant angle.

24. The method of claim 23, wherein the rotation invariant angle is defined by:

identifying at least one pattern index point on a contour of the pattern image;

identifying a front point and a back point for the pattern index point, the front point and back point defining a stick vector; and

identifying a R vector defined by the index point and the pattern reference point;

wherein the rotation invariable angle is defined by a SR angle between the stick vector and the R vector.

25. The method of claim 21, wherein the step of calculating a potential reference point based on the scene contour information and the reference table comprises:

identifying at least one scene index point on a contour of the scene image;

calculating the potential reference point for each of the scene index points based on the reference table;

adding the potential reference point to a reference point accumulator; and

determining a likely potential reference point.

26. A system for pattern identification, comprising:

a first image capture device that captures a pattern image, the pattern image including an image of a pattern;

a second image capture device that captures a scene image to be searched for the pattern;

a processor for processing the pattern image and the scene image, the processor

comprising:

means for extracting at least one pattern contour from the pattern image;

means for generating vector information for each of said at least one pattern contours, relative to a reference point;

5 means for creating at least one reference table for storing vector information, each of said at least one reference tables corresponding to at least one pattern contour;

means for extracting at least one scene contour from a scene image;

means for generating vector information for each of said at least one scene contours; and

10 means for locating the pattern image within the scene image using the at least one reference table and the vector information for the at least one scene contours.

27. The system of claim 26, further comprising:

a database for storing the at least one reference table.

15 28. The system of claim 27, wherein the database stores at least one reference table for a plurality of pattern images.

20 29. The system of claim 26, wherein the first image capture device and the second image capture device comprise a common image capture device.

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